SOLUTIONS NOTES:

SOLUTION:

SOLVENT:

SOLUTE

9 TYPES OF SOLUTIONS

Solution	Solvent	Example
gas	gas	
gas	liquid	
gas	solid	
liquid	gas	
liquid	liquid	
Solid	gas	
solid	liquid	
solid	solid	

Miscible

Like dissolves likes

Polar (electronegativity difference 0.5 - 1.67)

Nonpolar (Even distribution of + and - parts)

Ethanol - Has a polar side and a nonpolar side. Therefore it can dissolve polar and nonpolar substances . (What cellular structure is similar to this ?)

Solution notes continued

Saturated

Unsaturated

Supersaturated

What is the effect of pressure on the solubility of a gas ?

Henry's law:

What is the effect of temperature on solubility ?

a) solids in liquids

b) gases in liquids

What things increase the solubility of a solid in a liquid ?

a)
b)
c)

Solution Notes:

Solution: homogeneous mixture of two or more substances

Solvent: the dissolving medium. Ex: water is known as the universal solvent since so many substances dissolve in water.

Solute: the substance being dissolved. Ex: sugar, or salt

9 Types of Solutions

Solute in a	Solvent	Example
gas	gas	air
gas	liquid	soda
gas	solid	hydrogen on platinum(rare)
liquid	gas	water vapor in air
liquid	liquid	mixed drinks
liquid	solid	mercury in copper
solid	gas	sulfur vapor in air
solid	liquid	sugar water(recall: solubility charts and some substance dissolve and some don't)
solid	solid	copper in nickel(alloys)

Miscible: two liquids that are mutually soluble in each other(mixed drinks)

Immiscible: two liquids that are not mutually soluble in each other(oil and water)

Selective: some solvents dissolve substances readily while others do not.

Polar bond: Electronegativity difference between 0 and .49 is nonpolar covalent, between .50 and 1.67 is polar covalent, and between 1.68 and 3.30 is ionic.

Polar molecule: an uneven distribution of + and - parts and therefore the molecule is NOT symmetrical.

Example: Water has polar bonds(0=3.5 and H=2.2. A difference of 1.3) It is a polar molecule since it has two lone pairs that push the bonded pairs down forming an unsymmetrical shape, bent, with a bond angle of 104.5°.

Nonpolar molecule: an even distribution of + and - parts and therefore the molecule is symmetrical.

Example: Carbon tetrachloride has polar bonds(Cl=3.0 and C=2.5. A difference of .5) It is a nonpolar molecule since the four bonded pairs are in a symmetrical shape, tetrahedral, with a bond angle of 109.5°.

Like dissolves like(aka: nature of the solute):

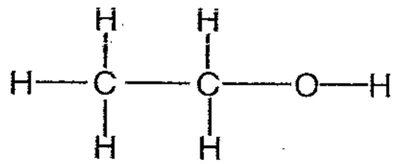
polar substances dissolve polar substance:
- sugar dissolves in water(both polar)
- tea dissolves in water(both polar)
- oil doesn't dissolve in water(oil is nonpolar and water is polar)

nonpolar substances dissolve in nonpolar substances:
- oil dissolves in carbon tetrachloride(both nonpolar)
- gum and peanut butter(the oil) both nonpolar

Soap is an emulsifying agent

Example: when you have oily hands and put them under water, your hands still feel oily(nonpolar and polar) but if you put soap in your oily hands and rub them together and then put them under water, they no longer feel oily. The soap breaks down the bonds so the water is now able to wash away the oil.

Ethanol, C_2H_5OH



ethanol has a polar side(O and H) and a nonpolar side(C and H) therefore, it is able to dissolve some polar AND nonpolar substances.

Saturated: the concentration of a mixture is at its maximum.

Unsaturated: the concentration of a mixture is below its maximum.

Supersaturated: the concentration of a mixture is above its maximum. How can this be done? How do you make a supersaturated solution?

Pressure on solubility:

pressure affects the solubility of a gas in a liquid(soda)
Henry's Law: for a gas in a liquid, the more pressure, the more dissolving
the less pressure, the less dissolving
Example: a freshly openned can of soda vs a can that has been open for a while

Effervescence: the giving off of a gas. Example: soda, champagne.

Temperature on solubility:

a) solids in liquids(sugar water)
when temperature increases, solubility increases

b) gases in liquids(soda)
when temperature increases, solubility decreases
when soda is left out in warm weather, it naturally become flat.

Increasing dissolving(for a solid in a liquid), aid in the dissolving process faster, or how to make a supersaturated solution:

a) stirring
b) powdering the solid so it will be easier to dissolve(example: sugar cubes vs granulated sugar, whole herbs and spices vs ground herbs and spices)
use a mortar and pestle to powder solids
c) heating the solvent

Note: if a foreign substance(string, crystal, etc.) is added to a warm supersaturated solution and is then let to cool down, a precipitate forms. This is known as seeding the solution.

Exothermic: the temperature of the solution increases as the solid dissolves.

Endothermic: the temperature of the solution decreases as the solid dissolves.

I. Title: Rock Candy

II. Purpose: write in sentence form and be sure to include the words solute, solvent, and supersaturated.

III. Materials: list all the materials you used and the amounts of each used. Be creative with the colors and flavors!!!

IV. Procedure: include a detailed description of what you did to make your rock candy. Have it be in the form: step 1, step 2, step 3, etc.....

V. Analysis:

1. What is the solute in making rock candy?
2. What is the solvent in making rock candy?
3. What type of solution are you trying to make?
    a) Which of the 9 types of solutions are you making?
    b) Was your solution unsaturated, saturated, or supersaturated? How do you know?
4. Using the theory of like dissolves like, relate this theory to this experiment.

VI. Conclusion:

Two paragraphs only

a) What did you learn?

b) Did you accomplish the purpose? Include if your experiment worked and what you could have done to improve it.

YOU MUST INCLUDE THE RECEIPE YOU USED (PRINT IT OUT IF YOU GOT IT OFF THE COMPUTER, AND XEROX IT OFF IF YOU GOT IT FROM A COOKBOOK.

YOU MUST ALSO INCLUDE A SAMPLE OF YOUR ROCK CANDY. EVEN IF IT DOESN'T TURN OUT, YOU MUST BRING IN THE CONTAINER, ETC. TO PROVE YOU DID TRY IN ORDER TO GET MAXIMUM CREDIT!!!!

Name: Date:

Solubility Worksheet

*Look at Figure 13-10 for the following:

1. What is the solubility of KNO_3 at 30°C?

2. What is the solubility of KNO_3 at 70°C?

3. Which compound varies the least in solubility over the temperature range of the graph?

4. What change occurs in the solubility of $Ce_2(SO_4)_3$ as the temperature of the solution increases from 20°C to 100°C?

5. What is the difference between the solubilities of KNO_3 and NaCl at 24°C?

6. What is the difference between the solubilities of KCl and NaCl at 75°C?

7. What is the average rate of change of solubility of $NaNO_3$ in grams per 100g of water per Celsius degree from 10° to 30°C? (use slope formula).

8. At what temperature does NaCl have the same solubility in grams per 100g of water as KNO_3?

9. In terms of solubility in grams per 100g of water, how does the solubility of KNO_3 compare with that of NaCl?

*Look at Figure 13-11.

1. What is the solubility of KI at 20°C?

2. What is the solubility of KCl at 50°C?

3. Which compound varies the least in solubility over the temperature range of the graph?

4. What is the difference between the solubility of $NaNO_3$ and KI at 30°C?

5. Does the solubility of $C_{12}H_{22}O_{11}$ decrease, increase, or remain the same, between 10°C and 50°C ?

6. At what temperature does NaCl and KCl have the same solubility?

7. Which has the greatest solubility in moles per 100g of water, KCl or KNO_3?

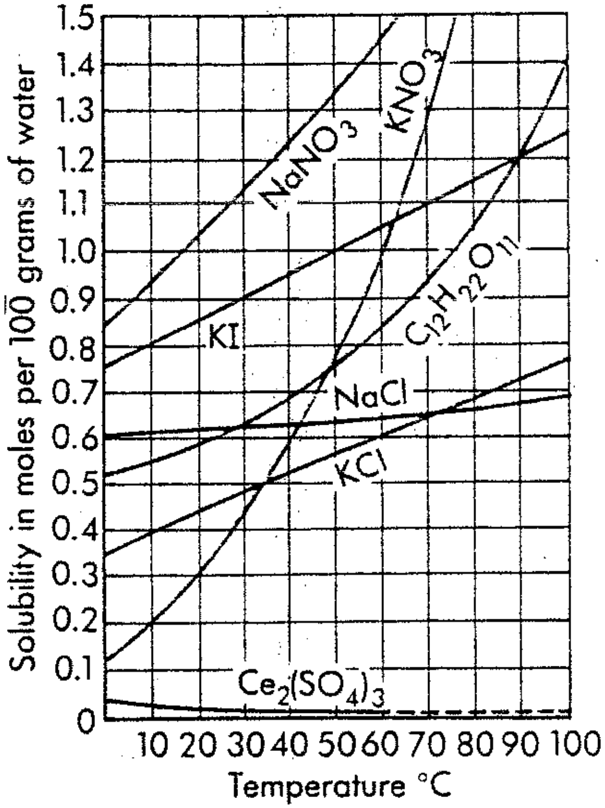


Figure 13-12. Solubility plotted in moles of solute per 10$\bar{0}$ grams of water as a function of temperature. Compare the relative positions of the curves with those shown in Figure 13-11.

Solubility of a solute depends on the temperature of the solvent.

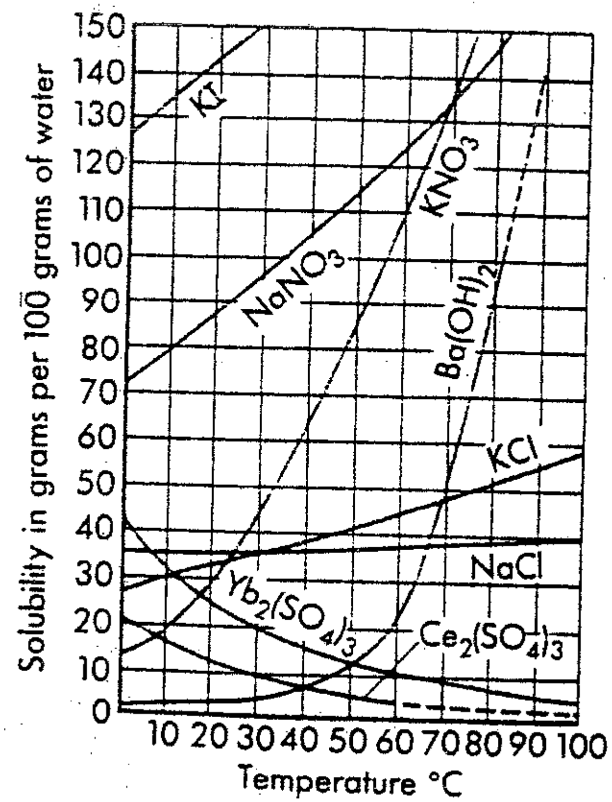


Figure 13-11. Solubility curves. The solubility of a solute is expressed in grams per 10$\bar{0}$ grams of water at a stated temperature.

Name:

Date:

Molarity Worksheet

1. How many grams of NaCl are contained in 150 ml of a .250 M solution?

2. What is the molarity of a $C_{12}H_{22}O_{11}$ solution that contains 537g of solute in 7.0 L of solution?

3. Calculate the molarity of a $CaCl_2$ solution that has 188g of solute in 4.5L of solution.

4. How many grams of KNO_3 are contained in 300 ml of a .750M solution?

Determining and Graphing the Effect of Temperature on Solubility — 29

The amount of a pure substance that will dissolve in a solvent varies with the temperature of the solvent. In this experiment the class will be divided into groups and each laboratory group will dissolve as much KCl in 100 g of water as possible at their assigned temperature. Each laboratory group will be assigned a different temperature. Each group will calculate the solubility of KCl in water and express the solubility as grams of KCl per 100 grams of water. The data from all groups will then be collected and compiled into a graph. From the graph, we will be able to determine the average values for the solubility of KCl in water for a wide range of temperatures.

Objective

In this experiment, you will determine the effect of heat upon the solubility of KCl in water.

Equipment

- evaporating dish
- test tube (150 mm × 18 mm)
- glass stirring rod
- funnel
- cotton
- 250 mL beaker
- laboratory burner
- ring stand and ring
- wire gauze
- clamps

Procedure

1. Your teacher will assign you and your partner a particular temperature for which you will determine the solubility of KCl in water.

3. Fill a 250 mL beaker about 2/3 full of water and place it on a wire gauze supported by a ring stand over a laboratory burner.
4. Place about 15 mL of distilled water in a clean 150 mm test tube.
   Immerse the test tube in the beaker of water as shown in Figure 29-1. Mass out 10g of KCl. Put aside.
5. Heat the water until it reaches the temperature that you were assigned. Maintain the water at this temperature. Slowly add KCl, stirring constantly, a little at a time. Continue adding till no more dissolves.
6. Continue for 10 minutes. Stop adding KCl when no more dissolves. Take the mass of the remaining KCl and calculate
7. amount used by subtraction. (10g KCl − remaining KCl = KCl dissolved)
8. Remove the test tube from the water bath and clean up.

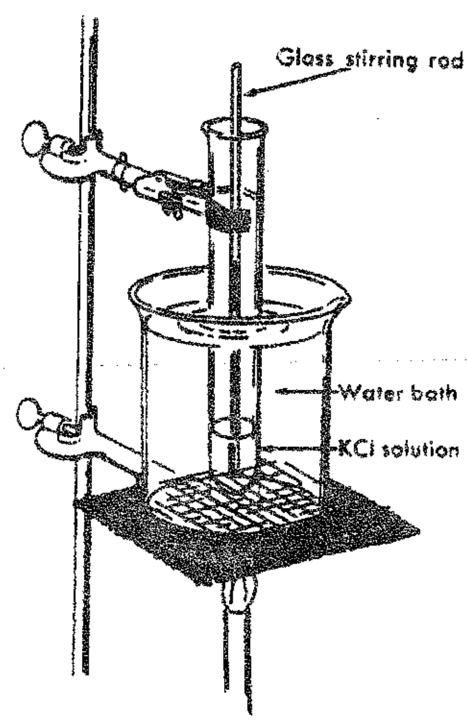


FIGURE 29-1. Apparatus set-up for dissolving KCl.

Calculations

1. Determine the mass of dry KCl used and water (15 mL) from the solution tested.
2. Using the mass of KCl and water from Step 1, determine the number of grams of KCl present in 100 g of solvent. (This value is the value you should report.)
3. Collect the results from the other groups and place them in a table.
4. Construct a graph using the vertical axis for grams of solute per 100 g of solvent and the horizontal axis for temperature.

Questions

1. Do all salts increase in solubility with an increase in temperature?
2. From your graph, predict the solubility of KCl at 10°C.

DATA TABLE

GROUP	TEMPERATURE °C	KCl DISSOLVED g
A	30	
B	35	
C	40	
D	45	
E	50	
F	55	
G	60	
H	65	
I	70	
J	75	
K	80	
L	85	

Name________________________________

DILUTIONS LAB

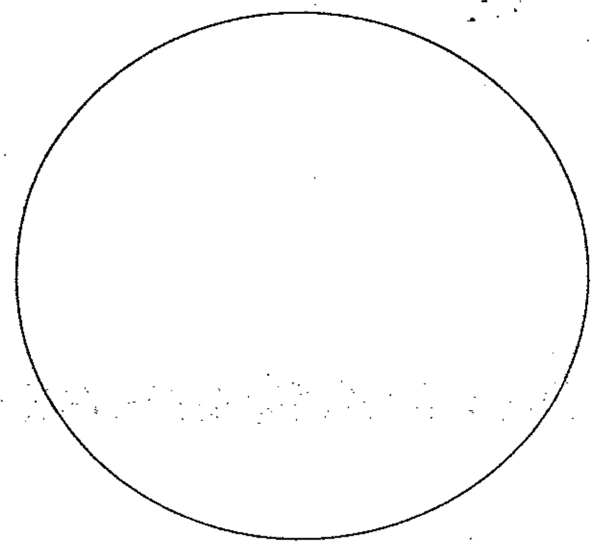
Purpose: *To see what happens to the concentration of a NaCl and water solution when you do a 1 to 1 and a 1 to 9 dilution. Also to observe and compare the results between a 1 to 1 and 1 to 9 dilution to its original solution by making drawings of the results under a stereomicroscope.*

Data Table:

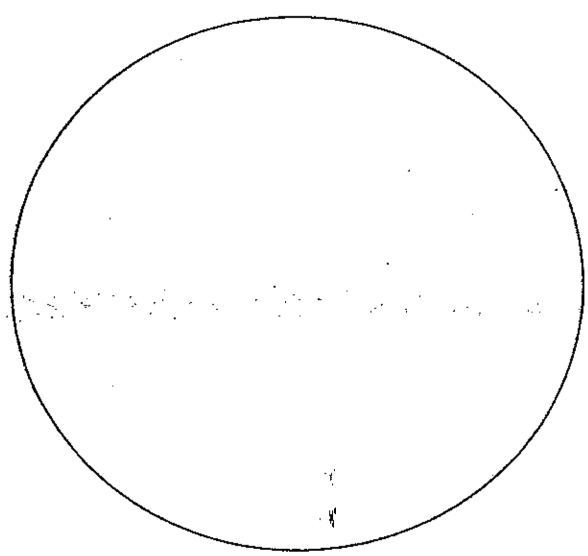
Mass of NaCl:	g
Mass of Petri dish # 1:	g
Mass of Petri dish # 2:	g
Mass of Petri dish # 3:	g
Mass of Petri dish # 1 + dried NaCl:	g
Mass of Petri dish # 2 + dried NaCl:	g
Mass of Petri dish # 3 + dried NaCl:	g

Drawings (under stereomicroscope):

Petri dish # 1



Petri dish # 2



Petri dish # 3

Chemistry Lab Dilutions

In this lab you will dissolve a quantity of NaCl in water and then do dilutions to make weaker solutions. At each step we will pour some of the solution into a petri dish and allow it to evaporate. We would like to see what happens to the concentration of a solution when you do a 1 to 1, and a 1 to 9 dillution.

Procedure:

1. Place about 80 ml of distilled water in a 250 ml beaker. Weigh out about 20.00g of NaCl. (It does not need to be exactly 20.00g, but we do need to know the exact mass).

2. Place the NaCl into the water and stir until it is completely dissolved.

3. Once the NaCl is completely dissolved, pour it into a 100 ml volumetric flask. Bring the volume up to 100ml. Call this, "solution #1" , in your lab report. Pour it back into the 250ml beaker.

4. Weigh three petri dishes and label them with your drawer number, and #1, #2, and #3. Using a 25ml graduated cylinder, measure 20ml of solution #1 and pour it into a petri dish that you have labeled with your lab drawer number and a , "#1".

5. Using a 100ml graduated cylinder, measure 50 ml of solution #1 and pour it into the volumetric flask. Bring this solution up to 100ml by adding distilled water. This will be called, "solution #2" . Empty the beaker and pour this #2 solution into the beaker.

6. Using the 25ml graduated to measure 20ml of soultion #2 into a second petri dish labeled with your drawer number and , "#2".

7. In the previous steps you did a 1 to 1 dilution of solution #1 to make solution #2. (50ml solution #1 + 50ml distilled water). Now using the same equipment, do a 1 to 9 dilution of solution #2 to make a solution you will call #3. Place 20ml of solution #3 into a third petri dish labeled with your drawer number and , "#3". You do not need to make any more solutions, so wash out all the glassware with tap water, and then rinse with distilled water last.

8. Place your three petri dishes in the spot your teacher tells you to let them evaporate overnight.

9. The next day, weigh the three petri dishes with the dried salt in them.

Calculations and Questions:

1. Determine the amount of NaCl in each of the three petri dishes by subtracting the mass of the petri dish.
2. Starting with the original mass of NaCl measured, determine how many grams of NaCl, <u>should</u> be in each petri dish based on your dilutions.
3. Compare your values in the last two steps by doing a % error. (use the value calculated from the original mass as the known value and the one obtained from the petri dishes as the experimental)
4. Did your petri dishes contain the amount of NaCl you predicted? What errors could account for any differences?
5. Why is it necessary to do dilutions when making very dilute solutions? (Why not make them up directly?
6. In what areas of science would dilutions be necessary?

Chemistry Lab Dilutions

In this lab you will dissolve a quantity of NaCl in water and then do dilutions to make weaker solutions. At each step we will pour some of the solution into a petri dish and allow it to evaporate. We would like to see what happens to the concentration of a solution when you do a 1 to 1, and a 1 to 9 dilution.

Materials:
3 petri dishes
20 g NaCl
1 50 ml or 100 ml volumetric flask
1 25 ml and/or 100 ml graduated cylinder(s)
China marker for labeling petri dishes

Task:

1) In the first petri dish, you are to place 20 ml of solution #1 which is made from 20 g NaCl in 100 ml H_2O or 10 g NaCl in 50 ml H_2O (depending on your volumetric flask)

2) In the second petri dish, place 20 ml of a solution you have made by doing a 1 to 1 dilution of solution #1

3) In the third petri dish, place 20 ml of a solution you have made by doing a 1 to 9 dilution of solution #2

Place your labeled 3 petri dishes under the hood to dry and mass them tomorrow.

... day, weigh the three petri dishes with the dried salt in them.

Calculations and Questions:

1. Determine the amount of NaCl in each of the three petri dishes by subtracting the mass of the petri dish.
2. Starting with the original mass of NaCl measured, determine how many grams of NaCl, <u>should</u> be in each petri dish based on your dilutions.
3. Compare your values in the last two steps by doing a % error. (use the value calculated from the original mass as the known value and the one obtained from the petri dishes as the experimental)
4. Did your petri dishes contain the amount of NaCl you predicted? What errors could account for any differences?
5. Why is it necessary to do dilutions when making very dilute solutions? (Why not make them up directly?
6. In what areas of science would dilutions be necessary?

Title: Molarity

Procedure: Each lab group will be assigned a chemical that they will use to make a specified M solution in a specified volumetric flask. Each solution is one that has been used thus far in this course or will be used in the future for other labs. Each person will write a narrative of their process in making the solution(including calculations). After their solution is made, each group will pour 20 ml of their made solution into a massed, labeled petrie dish and let the solution dry in order to let the crystals precipitate out. Each group will then mass these crystals and then calculate their experimental M of their assigned solution. The crystals will then be observed under a stereoscope and drawn to scale for a grade. Detail is important!! Each group's experimental M will then be compared to the theoretical M that was assigned and a grade will be given. The percent error will then be calculated. If the percent error is within an acceptable range, I will use their solution for the next chemistry classes labs.

I. Title: Molarity

II. Purpose: You write this!!!!

III. Procedure: Narratively describe how you made your assigned chemical's M in the specified flask. Include equipment used(3 pts), a detailed procedure(5 pts), and the calculation(s)(5 pts) necessary to make the theoretical M solution. (.01 or .0001 as appropriate).

IV. Data:(8 pts)

a. Name of the crystals____________________
b. Formula of the crystals____________________
c. theoretical M desired________________
d. mass of crystals used to make the solution________________
e. volume of the flask used to make the solution________________
f. mass of empty, labeled petrie dish________________
g. mass of crystals recovered in 20 ml solution poured in petrie dish___________
h. observations of crystals recovered:

i. drawing of recovered crystals as seen under the stereoscope(detailed)(4 pts)

V. Calculations:(12 pts)

a. Experimental M calculation(.01 or .0001 as appropriate)(4 pts)
b. Percent error M calculation(.01%)(4 pts)
c. Accuracy grade(4 pts)

0.00 to 5.00%	-0	5.01 to 10.00%	-1	10.01 to 15.00%	-2
15.01 to 20.00%	-3	20.01 or more%	-4		

VI. Analysis: (3 pts) Answer the following questions comparing .1M -vs- 1 M

a. Which is more concentrated?
b. How many times more concentrated is it?
c. What is the name of the flask used to make either of these two solutions?

VII. Conslusion: Two paragraphs only. What did you learn? Did you accomplish the purpose and how do you know?

Chemistry Lab The Case of the Forgotten Molarity

Purpose: To apply the concepts of stoichiometry, limiting reagents, and molarity to a real life situation.

Problem: Dr. Watson has forgotten the molarity of a solution of hydrochloric acid. At his disposal are a few pieces of magnesium metal along with a variety of pieces of lab equipment. Help Dr. Watson determine the molarity of the solution of hydrochloric acid.

Equipment Found in the Lab:

- Electronic Balance and Weighing paper
- Evaporationg dish
- Hot Plate under the ventilation hood
- Hydrochloric acid solution with unknown molarity
- Magnesium metal strips
- Graduated cylinder
- Beakers

Assignment: Using the equipment given, develop a procedure for determining the molarity of the hydrochloric acid solution. When you have outlined your procedures, have your teacher check them to be sure that they are safe.

Carry out your procedure and take any data necessary to determine the molarity of the acid solution.

Lab Write-up

Write up your lab as a story or a narrative. Explain to Dr. Watson what you did and why you did it. Include any calculations in your narrative, as part of the explanation. Be sure to explain to Dr. Watson any problems that might have occured during ther investigation and the amount of confidence you have in your answer.